ELECTRON EXCITATION OF THE H_2 ($a\ ^3\Sigma^+_g \rightarrow b\ ^3\Sigma^+_u$) CONTINUUM IN THE VACUUM ULTRAVIOLET(*)

J. M. Ajello, I. Kanik and G. K. James

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109

and

D. E. Shemansky

University of Southern California, Department of Aerospace Engineering, Los Angeles, CA 90089

Planetary exploration has pointed out the need for accurate electron impact excitation cross sections for H_2. The partitioning of energy in deposition processes in the outer planet atmospheres requires accurate measures of dissociation rates in H_2 particularly at low electron energies. A contributing process is the release of two fast H atoms in the H_2 ($a\ ^3\Sigma^+_g \rightarrow b\ ^3\Sigma^+_u$) transition. The quantum yield in the threshold energy region between vacuum ultraviolet (VUV) emission production by the band systems of the singlet and triplet states and dissociative production of fast H(1s) atoms by the triplet states is essential for energy budget modeling in planetary atmospheres and astronomy.

The electron excitation function for the H_2 ($u\ ^3\Sigma^+_g \rightarrow b\ ^3\Sigma^+_u$) continuum emission has been measured from 11 to 30 cv at 195.0 nm. The emission cross section data have been combined with the electron energy loss cross section measurements to extend the experimental data to 60 eV. The excitation cross section has been estimated by normalizing the data to the electron energy loss cross section at 20 eV and using a model to account for emission from the entire band system (120-500 urn). The spin forbidden excitation of the $a\ ^3\Sigma^+_g$ state is a major dissociative channel of H_2 at low energy with a peak cross section of 1.7×10^{-17} cm^2 at 15.5 eV. The high energy dependence of the cross section has a rapid $1/E^3$ fall off with electron energy, E, above 50 eV. A modified Born Approximation analysis was applied to the data to provide an analytic model. Fig. 1 shows the far ultraviolet (FUV) spectrum of electron excited H_2 at 20 eV along with the H_2 ($a\ ^3\Sigma^+_g + b\ ^3\Sigma^+_u$) excitation function. The calibrated spectrum is obtained at a spectral resolution of 0.5 nm from 110 to 210 nm. The highlighted region in the spectrum indicates the wavelength and band pass for the excitation function measurement.

The experimental apparatus and VUV calibration techniques have been described in detail elsewhere[2]. A magnetically collimated beam of electrons at a certain impact energy is introduced into the interaction region. The H_2 is introduced into the chamber in either static gas mode or crossed beam mode. The latter mode utilizes a capillary array. Emitted photons corresponding to the radiative decay of collisionally excited states of H_2 are detected at 90° by a commercial 0.2 meter vacuum monochromator equipped with a detector system which operates in the 110-300 nm region. The background gas pressure for the determination of H_2 emission cross sections was chosen to ensure optically thin conditions.

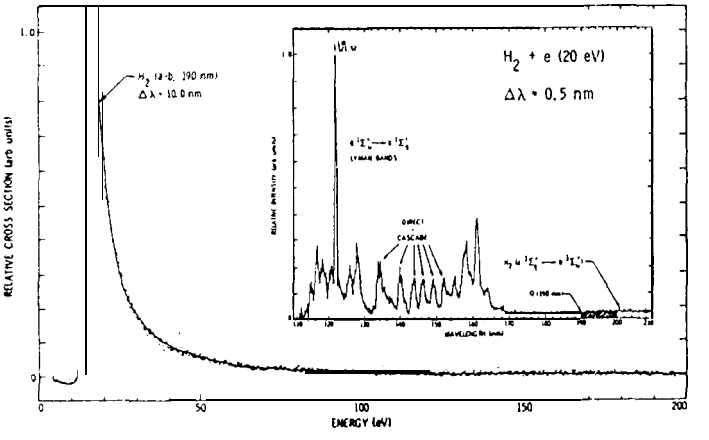

Fig. 1. FUV spectrum of electron excited H_2 and H_2(a-b) excitation function.

References:

1. M. Khakoo and S. Trajmar, *Phys. Rev.* 34, 146, 1986.
2. Ajello et al., *Appl. Opt.*, 27, 1988.

(*): This work was supported by NASA.